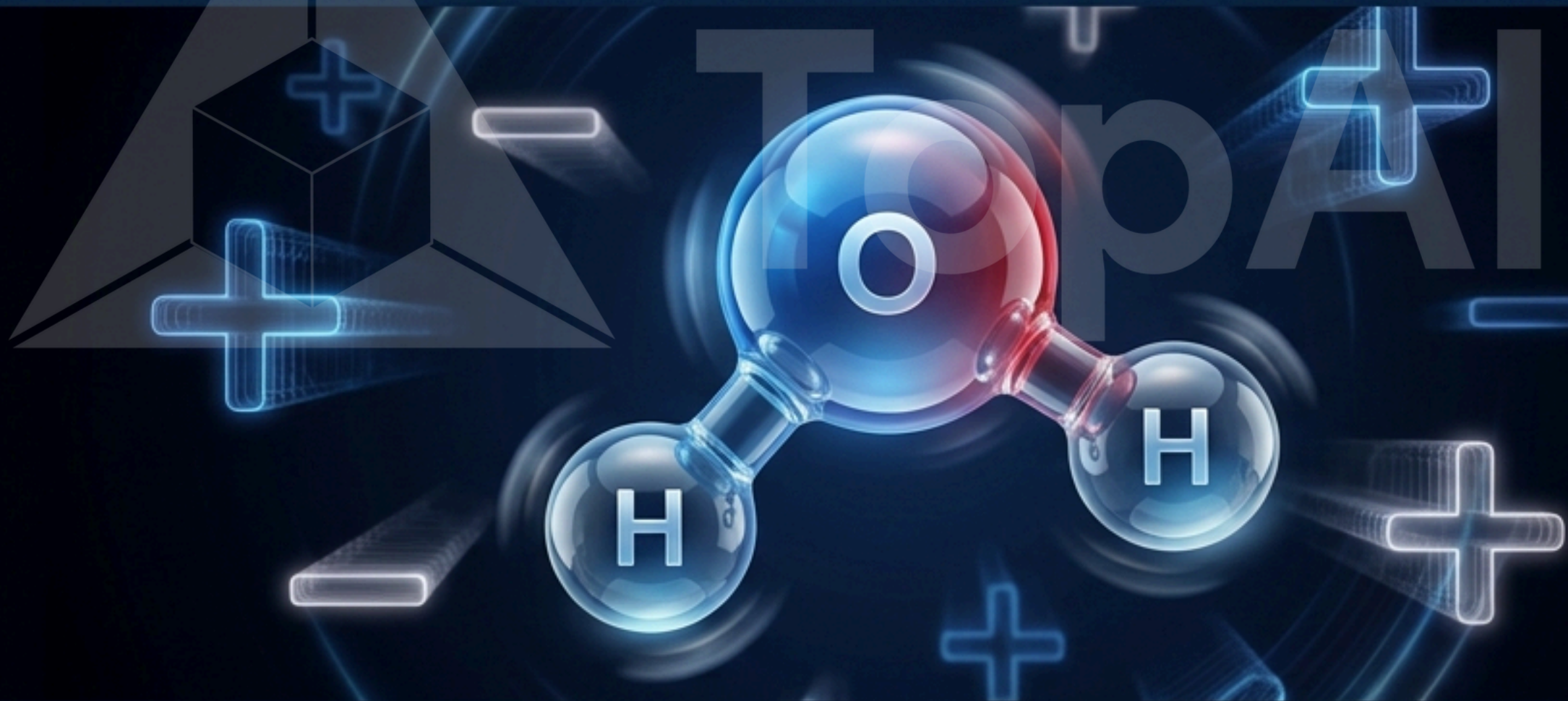
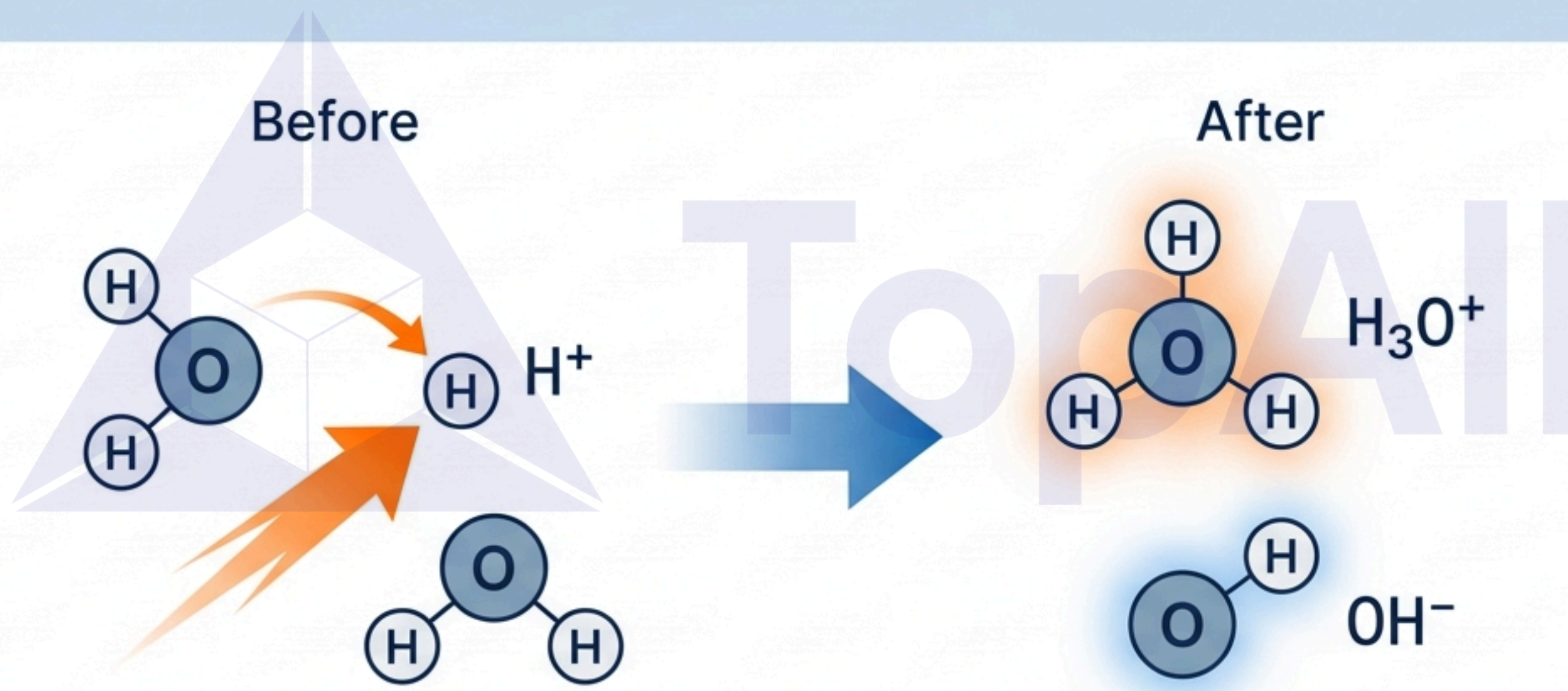


Pure Water Is Not Ion-Free

Understanding the Ionic Product of Water (K_w)



At any given moment, a tiny fraction of water molecules collide with enough energy to exchange a proton. This is Auto-protolysis.



Only ~2 in every 10^9 molecules are dissociated at a given time.



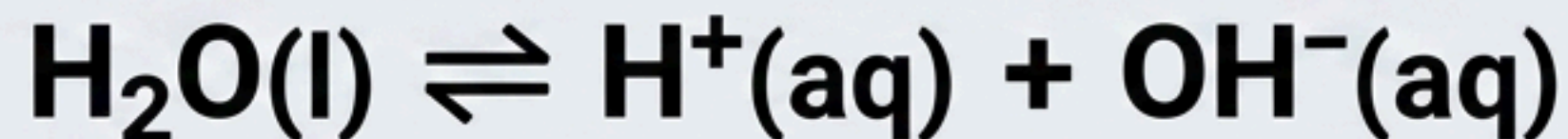
Proton Donor
(Brønsted Acid)

Proton Acceptor
(Brønsted Base)

Conjugate
Acid

Conjugate
Base

Simplified JEE Standard Notation:





You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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Step 1: Standard Equilibrium

$$K = [\text{H}^+][\text{OH}^-] / [\text{H}_2\text{O}]$$

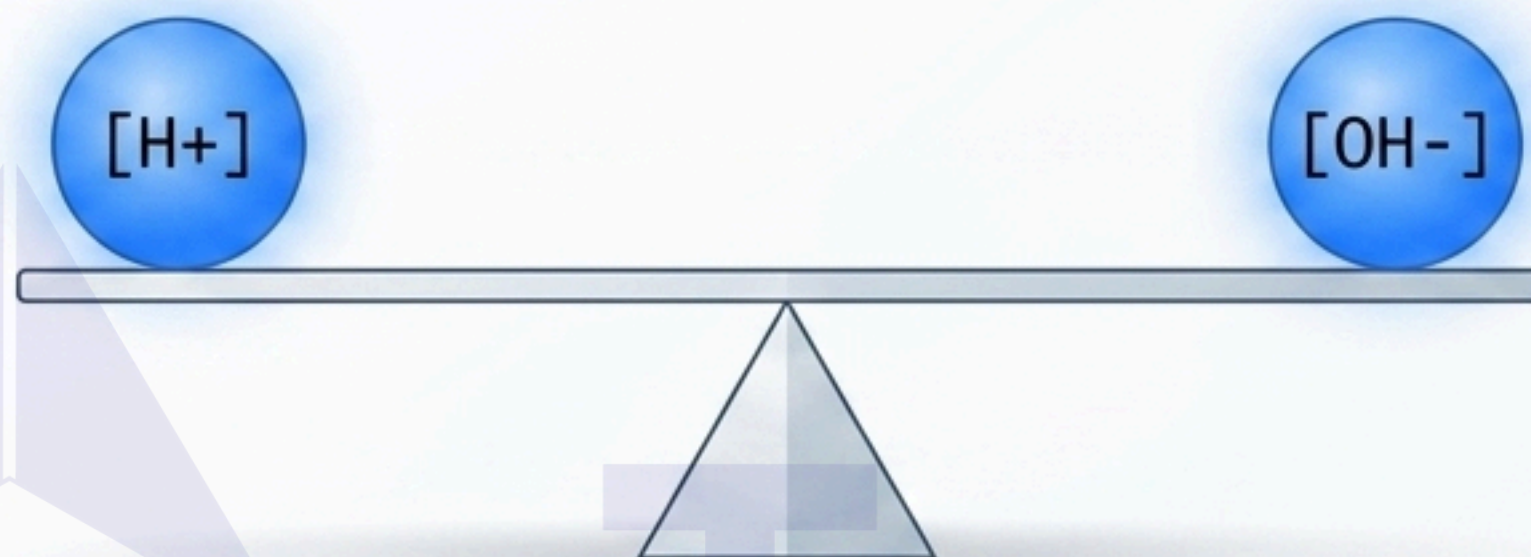
Step 2: The Insight

Water is a pure liquid. Its density is 1000g/L and molar mass is 18g/mol. Therefore, $[\text{H}_2\text{O}] = 55.55 \text{ M}$. Because only 2 in 10^{19} molecules dissociate, this concentration remains virtually constant.

Step 3: Combining Constants

$$K \times [\text{H}_2\text{O}] = K_w$$

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14} \text{ M}^2 \text{ (at 298K)}$$



In pure water, exactly one H⁺ and one OH⁻ are produced per dissociation.

Since $[H^+] = [OH^-]$

$$[H^+]^2 = 1.0 \times 10^{-14}$$

$$[H^+] = [OH^-] = 1.0 \times 10^{-7} \text{ M}$$

(at 298K)

Conclusion: Neutrality is a state of exact ionic balance, not an absence of ions.

Acidic

$[H^+] > [OH^-]$
(or $[H^+] > 10^{-7} \text{ M}$)

Neutral

$[H^+] = [OH^-]$
(exactly 10^{-7} M)

Basic

$[H^+] < [OH^-]$
(or $[H^+] < 10^{-7} \text{ M}$)

JEE Trap Alert

Neutral $\neq$ Absence of Ions!

An examiner will try to trick you into stating that a neutral solution has zero H^+ or OH^- ions.

Reality: It has exactly 10^{-7} M of BOTH at 298K. They simply cancel each other out.

🎯 Exam Snapshot: Ionic Product of Water

- **K_w Definition:** $K_w = [H^+][OH^-]$
- **Standard Value:** $K_w = 1.0 \times 10^{-14} \text{ M}^2$ (at 298K)
- **Crucial Dependency:** K_w is an equilibrium constant. Its value ONLY changes with Temperature.
- **Auto-protolysis:** Water acts as BOTH a Brønsted acid (proton donor) and Brønsted base (proton acceptor).

Ready for pH Calculations



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